





Center for In Situ Exploration and Sample Return

Environmental Challenges for Next Generation Exploration Missions

David H. Rodgers

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Jet Propulsion Laboratory

California Institute of Technology

Pasadena, California







Environmental Challenges

Challenges and Objectives

- What are the missions that provide these challenges?
- What are the expected environments?
- The challenge is to successfully take scientific measurements in there environments
 - Initially for a few weeks
 - Converting to "continuous presence"
 - Where should we test or before deploying landers?







Environmental Challenges **CISSRRoadmap**

2010 2020 Vision All Accessible Bodies Venus Mars Exploration Comets & Asteroids Earth Analogs Europa Key Science Missions impact penetrators with high-g tolerant sensors Surface **Platforms** Short range rovers Long-range "field scientist" Cryobots for subsurface Long-life rovers with Subsurface explorers in support of sample rovers working in cooperative chemical and physical with exobiology ocean exploration return mission petworks microlabs microlabs Robotic sampling & sensor systems Atmospheric **Platforms** Instrumented lifting Probes for plasma Circumnavigating aerobots for high Short-life probes for atmospheric Multiprobes and aerobots particles, and field body vehicles resolution geochemistry and atmospheric composition and meteorology for outer planets Interstions dynamics for Mars & Yenus Sample Return Comets come sample return Mars rock and Sample return from Solar wind sample return soll sample return low-gravity bodies sample return Technology Highly survivable systems Highly distributed and interactive Fully autonomous fault-Sample handling and tolerant of temperature, pressure, imowiedge-based platform with

Advances

return technologies

radiation and impact extremes

tolerant platforms

advanced power sources

For updates, please contact William Hoffman at; william hoffman@jpl.nasa.gov

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Environmental Challenges

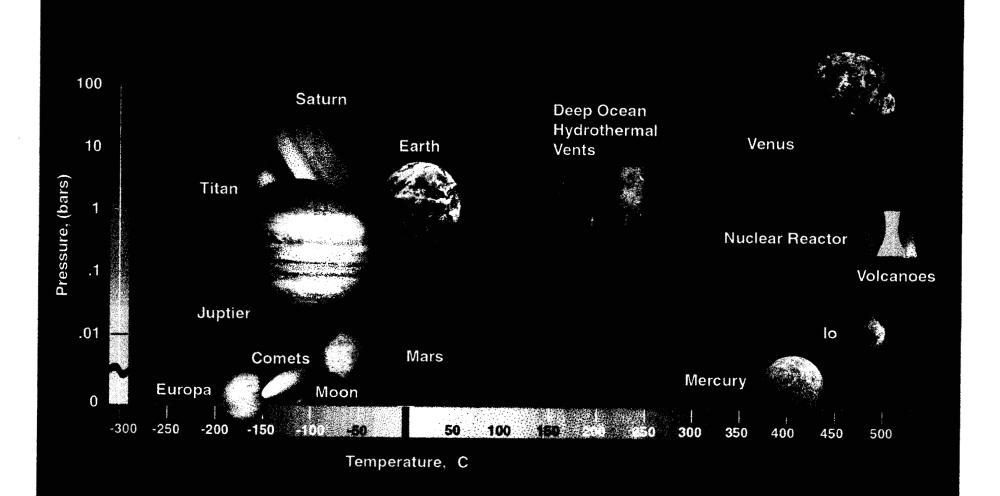
- Flyby and Orbiter missions must be designed for vacuum and solar/planetary radiation
- But, new In Situ or Sample Return missions face a different challenge with each destination
- Many different environments:
 - Some Extreme
 - All variable weather . . .
 - Plus the issues of getting in and out of planetary gravity wells





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Environmental Challenges Planetary Extremes

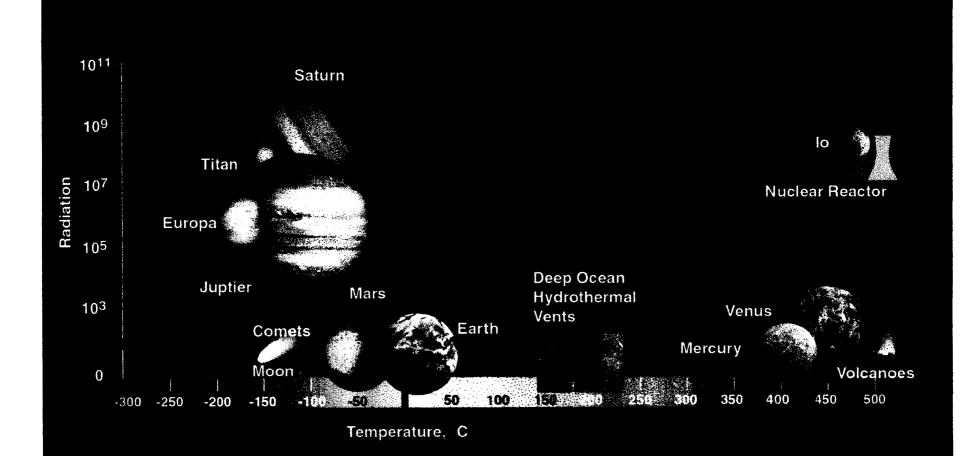






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Environmental Challenges Planetary Extremes









Environmental Challenges What will we measure?

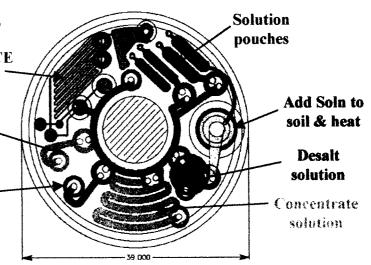
Integrate emerging technologies

Micro Micro
Electronics Fabrication

Micro

Biology

• Micro-capillary eletrophoresis chiral analysis Perform CE



analysis

Add chiral

separators

Add labeling

reagents







Environmental Challenges The Astrobiology Connection

Need coordinated suites of micro-laboratories to characterize solar system bodies and enable the search for life beyond earth

Looking for life

STRUCTURE

Unexpected shapes or organization

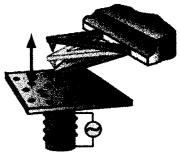


CHEMISTRY Complex molecules

High-energy molecules
Elemental or isotopic excess
Association of chemistry
with structure

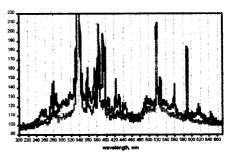
APPROACH

Develop analytical tools to solve biological, chemical and geological questions



Conduct tiered exploration in atmospheres, lithospheres, hydrospheres

- Move from broad to specific
- Low resolution to high resolution
- Non invasive to successively more invasive



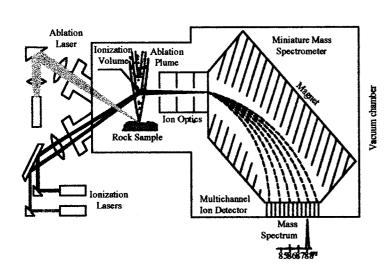








Environmental Challenges In Situ Geochronology Instrument



Scientific Goals of Instrument

- 1 Preselect samples for return from the surface of Mars
- 1 Calibrate Martian cratering record
- 1 Elucidate history of volcanism and Mars surface processes
- 1 Element ratios required to 6% or better; isotopic ratios to 0.1%

Measurements Made by Instrument

- 1 For at least two minerals in a rock, the isotopic ratio of ⁸⁷ Sr to ⁸⁶SR
- 1 For the same two (or more) minerals, the ratio of Rb to Sr

Instrument Description

- 1 Laser ablation sampling of rock sample surface
- 1 Selective ionization of Rb and Sr
- 1 Measurement of ion beam in sector-type miniature mass spectrometer

Development Status

- 1 Experiments to optimize laser ablation parameters in progress
- 1 Experiments in progress to develop Rb-Sr selective ionization techniques suitable for in situ instrument
- 1 JPL effort to develop in situ ablation laser suitable for instrument deployment

Ready for Flight Development in 2003

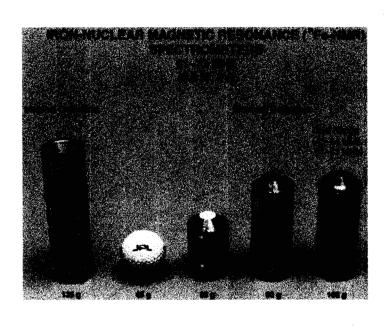
Profile Mass: 4 kg Power: 0.5 W Volume: 2000 cm³







Environmental Challenges Miniature Iron-Nuclear Magnetic Resonance (57Fe-NMR) Spectrometer



Scientific Goals of Instrument

1 Characterization of magnetic phase minerals in Martian soil, rock samples

Measurements Made by Instrument

- 1 Detection of Hematite, Magnetite from soil, mineral samples
- 1 Sensitivity 0.1 wt%

Instrument Description

- 1 Detection of magnetic phase minerals through interaction of iron nuclear spins with unique Internal magnetic field of sample
- 1 Consists of a radio frequency coil, continuous wave NMR circuit (marginal oscillator), digital signal processing circuit
- 1 Sample size: 1-2 cc

Development Status

1	Field tested:	in I	Lavic 1	Lake,	Mojave	Desert	with	Rocky-7	in May	1997
				,	•				•	

Ready for Flight Development? \square now \boxtimes '03 >'07

Profile Mass: 60 gm Power: 0.25 W

Volume: 60 cm³







Environmental Challenges

Learning to Study in Extreme Environments

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iments & ensors	Biological Geological Chemical	Robust Long duration	Highly integrated	Interscible
		Autonomous service véhicles	Vehicles with vision	Processors and a substance report
obols unications	Real-time data processing and analysis	Underwater communications	Through ice	Through water and ice
ceoling storiets	Packaging of sensors and electronics for extreme environment	Corrosion resistant materials High preseurs	Protection for operation for the cont water (eq.	
vidation		Precision three dimensional wide area acoustics system	Precision ice and water navigation ice penetrators	Nevigate within thick-ice lee penetrators
amination		Sterilized systems	Biologically, chamically Clean systems	Some of the second of the seco







Environmental Challenges Summary

- New technologies will be key to success just as they were in the past for remote sensing missions
- We need to leverage others investments to make these new missions affordable
- This is as big a step as going into space was 30 years ago





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